MASS WASTING SUMMARY
TOLT RIVER WATERSHED ANALYSIS

The mass wasting history of the Tolt river basin is closely tied to the glaciation of the basin. Many of the processes that are occurring today are the result of the events that occurred 10,000 or even 25,000 years ago. Two glacial processes have acted on this basin, one is the formation of alpine glaciers. These glaciers formed in the many glacial cirques in the eastern portion of the basin and flowed west. At the same time a large continental ice sheet occupied the western portion of the basin east to about South Fork Tolt Dam. About 10.000 years ago the ice melted, leaving its deposits behind, and the mass wasting began.

THE UPPER BASIN

This is the area that was occupied by the smaller alpine glaciers, underlain primarily by hard bedrock. Landslides associated with roads account for over 50% of the landslides in R 9E. This is probably the result of the older forest roads being constructed on fairly steep and difficult terrain. Also in this area a significant number of landslides are associated inner gorges (Figure 1.). Delivery of sediment to the main rivers is dependent on the gradients of the lower stream channels, many of which have large alluvial fan deposits on which the debris flows deposit.

THE LOWER BASIN

Landslides in the lower basin are primarily associated with one geologic unit, - Pre Fraser Glacial Deposits (Qpf). This unit consists of till, compacted coarse sands, and a mixture of fine sand and silt, that is approximately 25,000 years old and has been compacted twice by ice sheets. It occurs at two different elevations. At the lower elevations, along the main rivers, large deep seated ancient landslides are common in this unit (Figure 2). Shallow rapid landslides and some smaller deep seated failures are also occurring, both on the old landslide surfaces and on undisturbed portions of the formation. Delivery is variable and highly dependent on proximity to the river.

At the higher elevations, outcrops of the Pre Fraser Glacial Deposits can be found in the draws on the southern facing slopes in the north central portion of the basin. Here, the formation is not as thick or expansive as it is at the lower elevations and has been deposited directly on the bedrock (Figure 3.) Debris flows originating in the inner gorges of these draws are the primary mass wasting process. Large alluvial fans have developed at the base of some of these draws.

ANCIENT LANDSLIDES

There are 37 ancient deep seated landslides in the Tolt basin, which are primarily concentrated in two areas. Most of these landslides are along the Tolt River and the South Fork of the Tolt Rivers, in areas underlain by the pre Fraser Glacial Deposits. There is also a concentration of ancient landslides along the fault located just north west of the S. Fork Dam. A few other ancient landslides in bedrock, primarily rock slumps and rockfalls, are scattered throughout the basin. Some of the ancient slides in the basin are very stable while others have portions of them which are unstable. These unstable areas are usually were stream or river erosion is steepening old landslide deposits. A short description of each ancient slide is included in this report.

Figure 1. - Inner Gouge in Alpine Glaciated Area

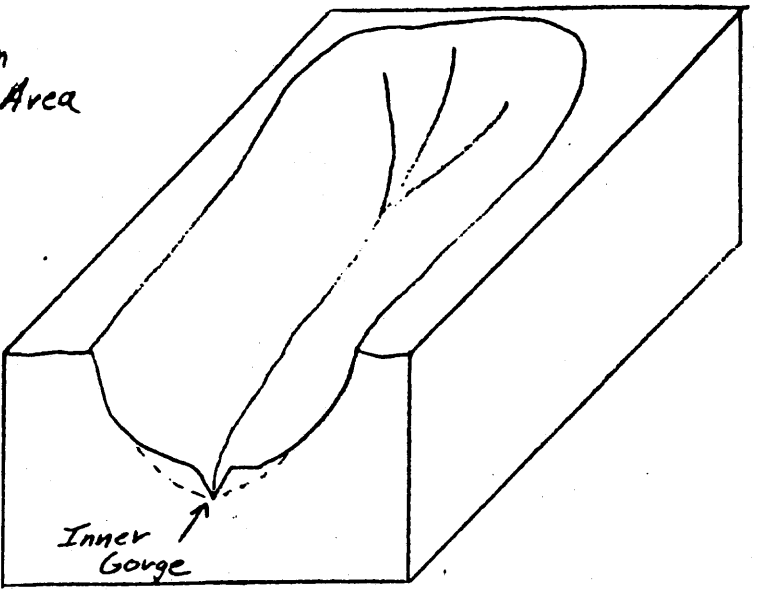


Figure 2. - Ancient Slump in QPF

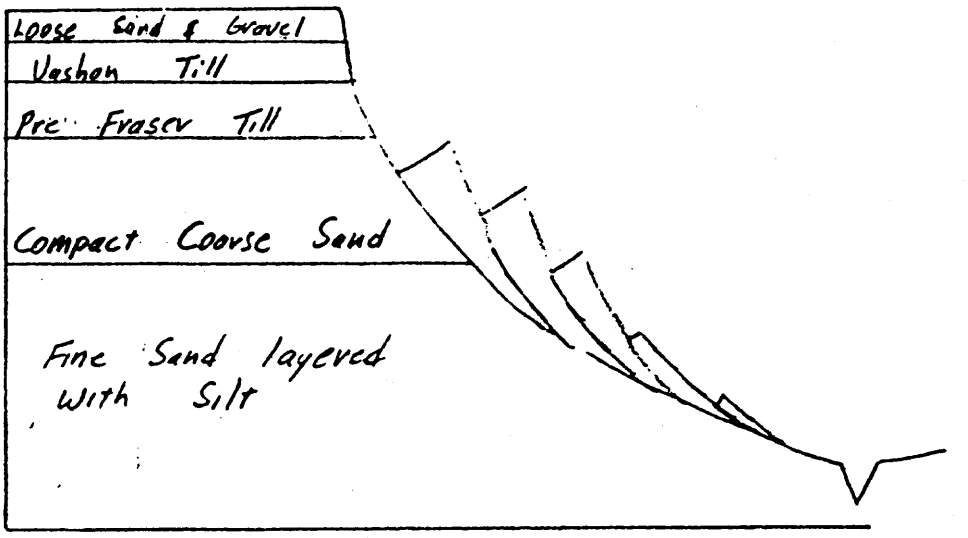
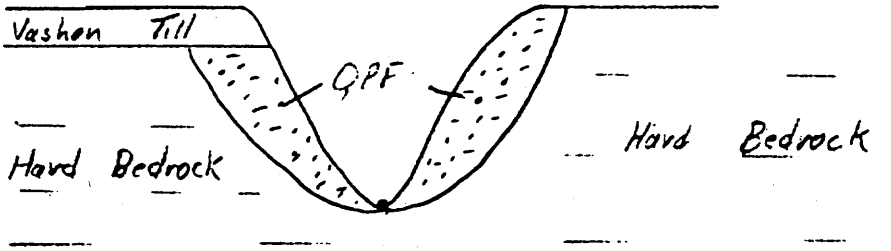


Figure 3 - Inner Gorge In QPF



TOLT RIVER WATERSHED ANALYSIS
METHODS AND COMMENTS

This analysis attempted to follow the methods described in Version 1.10 of the Watershed Analysis Manual as closely as possible. But, given the lack of information on pre-managed landslide frequency in much of the basin, landslide densities were used to determine mass wasting hazard. But this should yield comparable results since most of the basin already has been harvested once, and in some areas twice.

Mass wasting map units were delineated and rated based on three criteria; 1) Process 2) Delivery and 3) Frequency (density). Low hazard mass wasting units had a low probability of delivery and a low landslide density. Moderate hazard mass wasting units had possible to probable delivery and a landslide density of less than one non road related landslide per 160 acres. High hazard mass wasting map units have probable delivery and a landslide density of greater than one non road related landslide per 160 acres.

Because of the scale at which this analysis was done it should be recognized that this classification system represents a general slope stability classification for each map wasting map unit. Micro-sites of unstable ground or very stable ground may be included within each of the units, but these areas cannot be delineated at this scale and will need to be dealt with through more site specific "on the ground" approaches.

There were also a number of questions that were brought up during the analysis concerning what should be in the mass wasting module. Stream bank failures can be difficult to see on air photo, especially under timber, and the channel group may be better suited to document their locations and volumes. Any bank failures that were seen on the air photos were included in the landslide inventory and classified by the symbol SR/SA (shallow rapid failure / stream adjacent).

Surface erosion off of landslide scars was not addressed in the mass wasting module. Perhaps current landslide information should be routed to the surface erosion team sometime during the process for that to be included in their calculations.

The existence of a excellent geologic map of the area was key to this process. Without the existence of that map many more days would have been required to complete this process. Many thanks to Derek Booth.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 1

MU DESCRIPTION: Deeply incised inner gorge

MATERIALS: Shallow colluvial soils and glacial material over hard bedrock

LANDFORM: Inner gorge

SLOPE: > 65%

ELEVATION: 1,600 ft. - 3,800 ft.

TOTAL AREA: 269 ac.

MW TYPES: 10 road related failures and 6 non road related failures. SR, SR/SA, and DT.

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 269 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Failures are mainly associated with roads, both sidecast failures and fill failures. Stream crossing failures may a result of the active transport of woody debris and bedload down these channels, causing plugged culverts. Harves of the very steep slopes adjacent to streams seems to have accelerated mass wasting. This is probably due to root strength deterioration and changes in hydrology. Given the elevation and rock type root strength is probably the more important of the two.

CONFIDENCE: Certain that these areas are unstable (high landslide density) but less certain that some stable areas exist within this unit. Because of their thin narrow nature these units were hard to indentify. To be included in this unit slopes should be in excess of 65% and below a distinct break in slope.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 2

MU DESCRIPTION: Unstable portions of ancient landslides

MATERIALS: Landslide deposits

LANDFORM: Variable

SLOPE: > 45%

ELEVATION: 200 ft. - 3,200 ft.

TOTAL AREA: 380 ac.

MW TYPES: 3 road related failures and 16 non road related failures. Mostly SR, some SSD and an occasional DT

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 24 acres

FP SENSITIVITY: Roading, changes in hydrology, root strength (on the steep toes), ground disturbance

DELIVERY: Probable and Immediate (Usually next to a stream or river)

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: These areas are underlain by weak material (mass wasting deposits) and drainage both surface and sub-surface has been disrupted by past failure. Also portions of the failures have become over-steepened by either past failure or subsequent stream or river erosion. In the glacial material occurrence of the natural small sporadic deep seated failures on the lower slopes of these failures indicate the strength of the material and groundwater is very important. Root strength will play a role in areas that have been over-steepened by stream erosion.

CONFIDENCE: Good, but anytime one is working on a disturbed landscape special attention should be given to over-steepened slopes. These would occur not only on the toe of the failure, but also any where a small stream is trying erode through the weak deposits.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 3

MU DESCRIPTION: Trace of distinct fault

MATERIALS: Highly weathered and sheared bedrock

LANDFORM: Variable, but mostly lower portion of a deeply incisted stream valley

SLOPE: Variable

ELEVATION: 1600 ft. - 3,200 ft.

TOTAL AREA: 92 ac.

MW TYPES: 0 road related failures and 2 non road related failures. DT (considerable initial volume because intitial failure may include more than just the soil layer)

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 45 acres

FP SENSITIVITY: Root strength, changes in hydrology, ground disturbance

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Decreases in root strength and changes in hydrology probably contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 4

MU DESCRIPTION: Precipitous slopes along the ice margin boundary

MATERIALS: Various ice margin deposits over bedrock

LANDFORM: Precipitous straight slopes

SLOPE: > 65%

ELEVATION: 1,600 ft. - 3,200 ft.

TOTAL AREA: 613 ac.

MW TYPES: 5 road related failures and 4 non road related failures. Mostly DT, some LPD in both bedrock and glacial deposits

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 153 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance.

DELIVERY: Possible but not assured

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Failures originating from sidecast roads accounted for the majority of the failures within this unit. Decreases in root strength and changes in hydrology probably contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 5

MU DESCRIPTION: Older alpine drift over bedrock on precipitous slopes

MATERIALS: Older alpine drift over bedrock

LANDFORM: Precipitous straight slopes

SLOPE: > 65%

ELEVATION: 1,200 ft. - 3,000 ft.

TOTAL AREA: 128 ac.

MW TYPES: 0 road related failures and 2 road related failures, all DT

FP SENSITIVITY: Roading, root strength, change in hydrology, ground disturbance

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 64 acres

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Debris torrent are occurring along the contact between the Qoad and the bedrock along the very distinct break in slope. This situation can be aggravated with the loss of root strength and changes in hydrology.

CONFIDENCE: A definite zone of instability exists along the top of this unit but lower slopes may or may not contain the glacial material over the top of the bedrock and this lower area may have a somewhat higher degree of stability.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 6

MU DESCRIPTION: Oversteepened slopes opposite ancient landslides

MATERIALS: Vashon age glacial till and ressional outwash

LANDFORM: Precipitous stream adjacent slopes

SLOPE: > 65%

ELEVATION: 1,300 ft. - 1,600 ft.

TOTAL AREA: 44 ac.

MW TYPES: 3 road related failures and 1 non road related, all SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 44 acres

FP SENSITIVITY: Roading and root strength

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Construction of sidecast roads on extremely steep uncompacted glacial material has resulted large backslope failures and dry ravel.

CONFIDENCE: Fairly good,

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 7

MU DESCRIPTION: High elv. pre Fraser glacial deposits (inner gorge)

MATERIALS: Compacted sands, sands marbled with silt, and silt

LANDFORM: Inner gorge

SLOPE: > 65%

ELEVATION: 1,400 ft. - 2,200 ft.

TOTAL AREA: 120 ac.

MW TYPES: O road related failures and 12 non road related failures, DT and SR.

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 10 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: These are naturally unstable slope but debris torrents may be accelerated due to loss of root strength and changes is hydrology.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 8

MU DESCRIPTION: High elevation pre Fraser glacial deposits

MATERIALS: Compacted sand, sand marbled with silt, and silt

LANDFORM: Straight and convergent topography

SLOPE: > 45%

ELEVATION: 1,800 ft. - 2,800 ft.

TOTAL AREA: 268 ac.

MW TYPES: 3 road related failures and 9 non road related failures, DT and SR.

NON ROAD RELATED LANDSLIDE DENSITY: **1 landslide per** 30 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Probable

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: These are naturally unstable slope but debris torrents may be accelerated due to loss of root strength and changes is hydrology

CONFIDENCE: Good, the upper portions of these units are definately in the pre Fraser glacial deposits. These deposits may or may not be present in the lower portions of these units so the stability of the lower portions of these units may be understated.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 9

MU DESCRIPTION: Steep rock slopes covered with a thin mantle of glacial deposits

MATERIALS: Glacial drift (Vashon till and possibly pre Fraser glacial deposits over bedrock

LANDFORM: Straight precipitous slopes

SLOPE: > 65%

ELEVATION: 1,800 ft. - 3,200 ft.

TOTAL AREA: 187 ac.

MW TYPES: 1 road related failure and 4 non road related, DT and SR.

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 47 acres

FP SENSITIVITY: Roading, root strength, change in hydrology, ground disturbance

DELIVERY: Possible but not probable

DELIVERED HAZARD RATING: HIGH

TRIGGER MECHANISMS: Decreases in root strength and changes in hydrology are probably contributed to increased landslide frequency.

CONFIDENCE: Only fair, deciding delivery to the flats adjacent to dry creek was difficult. The existence of the pre Fraser deposits is less certain in this MWMU than in MWMU 8. Because of the elevation of Polygon 8-9 no pre Fraser glacial deposits should be present, so the stability of that polygon may be understated.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 10

MU DESCRIPTION: Steep unstable slopes directly adjacent to the main river systems

MATERIALS: Qpf - Compacted sand, sand marbled with silt, and silt

LANDFORM: Precipitous slopes directly adjacent to the river particularly on outside bend of the river

SLOPE: > 45%

ELEVATION: 200 ft. - 1,400 ft.

TOTAL AREA: 245 ac.

MW TYPES: 1 road related failure and 5 non road related failures, all SR, some SR/SA (bank failures).

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 49 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: High

TRIGGER MECHANISMS: River erosion has steepened these all of these slopes, some to a extremely steep angle. These slopes may have failed naturally but decrease in root strength or changes in hydrology or ground disturbance have probably contributed to increased landslide frequency.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 11

MU DESCRIPTION: Unstable mass wasting deposits

MATERIALS: Mass wasting deposits over lacustrine deposits

LANDFORM: Toeslope

SLOPE: Moderate

ELEVATION: 1,600 ft. - 2,400 ft.

TOTAL AREA: 73 ac.

MW TYPES: 1 road related failure and 1 non road related failures. Very strange wide shallow SR that turned into a DT. Unusual failures, low slope

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 73 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Possible

DELIVERED HAZARD RATING: High

TRIGGER MECHANISMS: These weak landslide deposits are subject to increased landslide activity due to decline in root strength and changes in hydrology

CONFIDENCE: This is an unstable area but I am somewhat unsure of all the processes that are occurring. Numerous deep seated landslides in the area have left a confusing array of mass wasting deposits overlying lacustrine deposits. The one very large recent failure in this unit has a fairly unique form. Confident the area is unstable but unsure of the processes that are occurring. Area also includes recharge area of the recently reactivated SSD.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 12

MU DESCRIPTION: Low gradient valley bottoms

MATERIALS: Residual soils over alluviam and glacial deposits

LANDFORM: Valley Bottoms

SLOPE: < 45 %

ELEVATION: 60 ft. - 2,800 ft.

TOTAL AREA: 3,108 ac.

MW TYPES: None recorded

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 3,108 acres

FP SENSITIVITY: Fairly insensitive

DELIVERY: None, unless stream adjacent

DELIVERED HAZARD RATING: LOW

TRIGGER MECHANISMS: Ground slope is generally too low for failures to initiate.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 13

MU DESCRIPTION: Non delivering gentle to moderate slopes

MATERIALS: Colluvial, residual, or glacial soils over Br or Qd

LANDFORM: Variable

SLOPE: Variable, generally less than 45%

ELEVATION: 150 ft. - 3,800 ft.

TOTAL AREA: 23,674 ac.

MW TYPES: 0 Road related failures and 2 non road related failures, all DT

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 11,837 acres

FP SENSITIVITY: Fairly Insensitive

DELIVERY: None to Rare, unless stream adjacent

DELIVERED HAZARD RATING: LOW

TRIGGER MECHANISMS: The only two landslides to occur in this unit were caused by beaver damms that broke and caused dam break floods. No readily apparent connection with forest practices.

CONFIDENCE: Good,

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 14

MU DESCRIPTION: Distinct glacial cirques

MATERIALS: Rock bluffs in headwall, alpine till over bedrock at base

LANDFORM: Cirque - convergent topography

SLOPE: Headwalls 65%, base 0 - 40%

ELEVATION: 2600 ft. - 5,500 ft.

TOTAL AREA: 5,025 ac.

MW TYPES: 5 road related failures and 6 non road related failures, DT and SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 838 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology

DELIVERY: Probable

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Nearly half of the failure in this unit were road failures originated from sidecast roads. Natural failures accounted for 5 of the 6 non road related failures. Natural failure frequency may be increased due to root strength deterioration and changes in hydrology.

CONFIDENCE: OK, pretty large unit

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 15

MU DESCRIPTION: Straight smooth bedrock slopes

MATERIALS: Colluvial soils over bedrock

LANDFORM: Straight smooth slopes

SLOPE: > 45%

ELEVATION: 1,800 ft. - 5,000 ft.

TOTAL AREA: 2,607 ac.

MW TYPES: 6 road related failures and 4 non road related failures, mostly DT, some SR

NON ROAD RELATED LANDSLIDE DENSITY: **1 landslide per 652 acres**

FP SENSITIVITY: Roading, root strength, changes in hydrology

DELIVERY: Possible

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Failures originating from sidecast roads accounted for the majority of the failures within this unit. Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good, this unit was differentiated from mwmu 16 because of the lack of any strongly convergent topography, also the lack of any large non road related debris torrents.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 16

MU DESCRIPTION: Steep bedrock slopes, some strongly convergent topography

MATERIALS: Colluvial soils over bedrock

LANDFORM: Variable

SLOPE: > 45%

ELEVATION: 1,400 ft. - 5,500 ft.

TOTAL AREA: 12,383 ac.

MW TYPES: 18 road related failures and 10 non road related failures, DT and SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 1,250 acres

FP SENSITIVITY: Roading, root strength and changes in hydrology

DELIVERY: Possible

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Failures originating from sidecast roads accounted for the majority of failures within this unit. Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: OK, pretty large unit

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 17

MU DESCRIPTION: Precipitous ice margin slopes - low probability of delivery

MATERIALS: Various ice margin deposits over bedrock

LANDFORM: Straight slopes, no deep stream incision

SLOPE: > 65%

ELEVATION: 1,600 ft. - 3,200 ft.

TOTAL AREA: 810 ac.

MW TYPES: 4 Road related failures and 2 non road related failures, all SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 405 acres

FP SENSITIVITY: Roading, root stength, changes in hydrology

DELIVERY: Unlikely

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Failures originating from sidecast roads accounted for the majority of failures within this unit. Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 18

MU DESCRIPTION: Precipitous slopes in porous glacial material

MATERIALS: Glacial soils over recessional deposits

LANDFORM: Valley Walls

SLOPE: > 65 %

ELEVATION: 1,150 ft. - 1,300 ft.

TOTAL AREA: 23 ac.

MW TYPES: 0 Road related failures and 1 non road related failure (SR)

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 23 acres

FP SENSITIVITY: Fairly Insensitive

DELIVERY: Probable

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: These are slopes that are on the outside bends of the river and the primary trigger mechanism is stream erosion.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 19

MU DESCRIPTION: Precipitous rock faces with potential delivery

MATERIALS: Thin colluvial soils over bedrock

LANDFORM: Straight short steep slopes

SLOPE: > 65 %

ELEVATION: 600 ft. - 2,200 ft.

TOTAL AREA: 9,379 ac.

MW TYPES: 0 Road related failures and 1 non road related failure (SR)

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 9,379 acres

FP SENSITIVITY: Fairly insensitive

DELIVERY: Possible to Probable

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Very few landslides in this unit, does not seem to be sensitive to forest practices, possible trigger mechanisms could be loss of root strength and changes in hydrology.

CONFIDENCE: Fair, the distinction for this unit is primarily based primarily on delivery. These are steep slopes with the potential to deliver, but there is a fairly low probability of failure.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 20

MU DESCRIPTION: Ancient deep seated landslides

MATERIALS: Landslide debris

LANDFORM: Variable, humocky broken topography common

SLOPE: Variable

ELEVATION: 200 ft. - 3,000 ft.

TOTAL AREA: 3,682 ac.

MW TYPES: 7 road related failures and 30 non road related failures, SR, SSD, and DT.

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 263 acres

FP SENSITIVITY: Roading, changes in hydrology, root strength (toe and scarp), ground disturbance

DELIVERY: Variable

DELIVERED HAZARD RATING: MODERATE (HIGH harzard areas should be in mwmu #2)

TRIGGER MECHANISMS: Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Fair, each ancient landslide may be a little different, hence a seperate write up on each is included in this report.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 21

MU DESCRIPTION: Bedrock river gorge

MATERIALS: Skeletal to non existent soils over bedrock

LANDFORM: Rock Bluffs

SLOPE: > 65 %, commonly > 100%

ELEVATION: 500 ft. - 1,200 ft.

TOTAL AREA:

MW TYPES: Rockfalls

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 278 acres

FP SENSITIVITY: Fairly insensitive, but may be effected by ground disturbance or possibly root strength

DELIVERY: Probable and immediate

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Landslides (rockfalls) in this area area probably triggiered by expansion in joints by freezing and thawing.

CONFIDENCE: Fair to Good, difficult to traverse and to see on photos.

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 22

MU DESCRIPTION: Steep upland valley walls in Qpf

MATERIALS: Compacted sand, sand marbled with silt, and silt.

LANDFORM: Valley Walls

SLOPE: > 45 %

ELEVATION: 200 ft. - 1,800 ft.

TOTAL AREA: 1,282 ac.

MW TYPES: 0 Road related failures and 7 non road related failures, mostly SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 180 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology, ground disturbance

DELIVERY: Doubtful to Possible or Probable

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good

MASS WASTING MAP UNIT DESCRIPTION FORM

MU NUMBER: 23

MU DESCRIPTION: Steep rock face with possible glacial deposits

MATERIALS: Colluvial soils with possible glacial material over bedrock

LANDFORM: Straight steep slopes

SLOPE: > 65 %

ELEVATION: 1,600 ft. - 4,000 ft.

TOTAL AREA: 3,251 ac.

MW TYPES: 2 Road related failures and 2 non road related failures, DT and SR

NON ROAD RELATED LANDSLIDE DENSITY: 1 landslide per 1,625 acres

FP SENSITIVITY: Roading, root strength, changes in hydrology

DELIVERY: Unlikely

DELIVERED HAZARD RATING: MODERATE

TRIGGER MECHANISMS: Failures originating from sidecast roads accounted for the road related failures within this unit. Decreases in root strength and changes in hydrology may have contributed to increased landslide frequency of non road related failures.

CONFIDENCE: Good

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-01L1(1958)	DT/d	1	Y/4	NR		100
26/09E-01L2(1976)	SR/q	1	Y/4	R	SC	20-
26/09E-01P1(1970)	DT/d	1	Y/4	NR		20-
26/09E-01R1(1976)	SR/q	1	Y/4	R	SC	20-
26/09E-01R2(1976)	DT/d	1	Y/4	R	SX	20-
26/09E-01R3(1980?	DT/p	1	Y/4	R	SX	20-
26/09E-02J1(1982)	DT/p	1	Y/4	R	SC	20-
26/09E-02J2(1982)	DT/p	1	Y/4	R	SC	20-
26/09E-02J3(1958)	DT/p	1	Y/4	NR		100
26/09E-02K1(1970)	DT/P	1	Y/1	NR		20-
26/09E-15D1(1976)	SR/p	1	Y/3	R	SC	20-
26/09E-16B1(1970)	SR/p	1	Y/3	R	SC	20-
26/09E-16K1(1970)	DT/p	1	Y/3	R	SC	20-
26/09E-16Q1(1970)	DT/p	1	Y/3	R	LND	20-
26/09E-21B1(1987)	DT/p	1	Y/4	NR		20-
26/10E-29D1(1982)	DT/p	1	Y/3	NR		100

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/08E-28N1(1974)	SR/d	2	Y/1	R		20+
26/08E-32D1(1982)	SR/d	2	Y/1	NR		20-
26/08E-32D2(1982)	SR/d	2	N	NR		20-
26/08E-32K1(1964)	SSD/p	2	N	NR		50+
26/08E-32L3(1964)	SSD/p	2	Y/1	NR		50+
26/08E-32L4(1964)	SR/q	2	N	NR		20-
26/08E-35D1(1964)	SR/d	2	Y/1	NR		100
26/09E-06F1(1988)	SR/p	2	Y/3	NR		20-
26/09E-09N1(1970)	SSD/d	2	Y/1	NR		20+
26/09E-09R1(1958)	SSD/d	2	Y/1	NR		100
26/09E-09R2(1987)	SSD/d	2	Y/1	NR		20+
26/09E-15C1(1958)	SR/p	2	Y/3	NR		100
26/09E-16E2(1970)	SR/d	2	N	R	BS	20-
26/09E-16M1(1974)	SR/d	2	Y/3	NR		20-
26/09E-30A1(1964)	SR/p	2	Y/4	NR		20+
26/09E-30H1(1976)	DT/p	2	Y/4	R	SC	20+
26/09E-31L2(1964)	SSD/d	2	Y/1	NR		20+
26/09E-31L3(1976)	SSD/d	2	Y/1	NR		20+
26/09E-31N3(1964)	SR/p	2	N	NR		20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-17C1(1974)	DT/p	3	Y/3	NR		20-
26/09E-30C1(1964)	DT/p	3	Y/4	NR		20+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/09E-06K1(1974)	DT/p	4	N	R	LND	20-
25/09E-06K2(1974)	SR/p	4	N	R	LND	20-
25/09E-06R1(1992)	DT/d	4	N	R	SC	20+
26/09E-04A1(1964)	DT/p	4	Y/4	NR		100
26/09E-04B1(1972)	DT/p	4	Y/4	NR		20-
26/09E-19A1(1974)	SR/d	4	N	R	SC	20-
26/09E-30G1(1991)	DT/p	4	N	R	SC	20+
27/09E-33R1(1964)	DT/P	4	Y/4	NR		20+
27/09E-33R2(1972)	DT/p	4	N	NR		20+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-29E1(1974)	DT/p	5	Y/4	NR		20-
26/09E-29G1(1974)	DT/p	5	Y/4	NR		20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-08K1(1964)	SR/d	6	Y	R	BS	20+
26/09E-08N1(1964)	SR/d	6	Y	R	BS	20+
26/09E-08P1(1964)	SR/d	6	N	NR		20+
26/09E-08P2(1964)	SR/d	6	Y	R	BS	20+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/08E-12J1(1964)	SR/d	7	Y/4	NR		20+
26/08E-12J2(1964)	SR/d	7	Y/4	NR		100
26/08E-12J3(1964)	DT/p	7	Y/1	NR		100
26/08E-13B1(1982)	SR/SA/p	7	Y/4	NR		20-
26/08E-13B2(1982)	SR/SA/p	7	Y/4	NR		20-
26/08E-13B3(1982)	DT/p	7	Y/1	NR		20-
26/08E-14C1(1964)	SR/SA/p	7	Y/4	NR		20-
26/08E-14L1(1964)	DT/P	7	Y/3	NR		20-
26/08E-14M1(1964)	DT/q	7	Y/4	NR		20-
26/08E-14M2(1964)	DT/q	7	Y/4	NR		20-
26/08E-14N1(1964)	SR/d	7	Y/4	NR		20-
26/08E-14N2(1964)	SR/SA/p	7	Y/4	NR		20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/08E-09R1(1964)	DT/d	8	Y/3	NR		100
26/08E-09R2(1964)	DT/d	8	Y/4	NR		100
26/08E-12B1(1970)	SR/p	8	Y/3	R	LND	20-
26/08E-12B2(1970)	DT/P	8	Y/3	NR		20-
26/08E-12R1(1958)	DT/p	8	Y/1	NR		20-
26/08E-12R2(1974)	SR/d	8	N	NR		20-
26/08E-15C1(1964)	SR/p	8	Y/4	NR		100
26/08E-15D1(1964)	DT/p	8	Y/4	R	SC	20-
26/08E-16B1(1964)	DT/p	8	N	NR		20+
26/08E-16B2(1992)	DT/p	8	Y/4	NR		20+
26/09E-06Q1(1970)	DT/q	8	Y/1	R?		100
26/09E-07J1(1972)	SR/q	8	Y/3	NR		20_

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-05D1(1988)	DT/q	9	Y/4	NR		20-
26/09E-05M1(1972)	SR/p	9	N	NR		100
26/09E-06A1(1984)	DT/p	9	N	NR		20-
26/09E-06C1(1988)	DT/p	9	Y/3	NR		20-
27/09E-31P1(1988)	SR/d	9	N	R	LND	20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/07E-01H2(1982)	SR/d	10	N	NR		20-
25/07E-01L1(1982)	SR/d	10	Y/1	NR		20-
26/08E-33M1(1964)	SR/d	10	Y/1	NR		100
26/08E-33N1(1964)	SR/d	10	Y/1	NR		100
26/08E-33N2(1964)	SR/d	10	N	NR		100
26/08E-33N3(1964)	SR/d	10	N	R	SC	20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-16G1(1970)	DT/d	11	Y/1	NR		20-
26/09E-16K2(1970)	SR/d	11	N	R	SC	20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/07E-01A2(1992)	DT/p	13	Y/1	NR		20+
26/08E-22A1(1974)	DT/d	13	Y/1	NR		20+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/09E-03D1(1988)	DT/p	14	Y/4	R	SC	20-
25/09E-03D2(1992)	DT/q	14	Y/1	R	LND	20-
25/10E-06M1(1964)	DT/p	14	Y/3	NR		100
26/09E-13L1(1964)	DT/q	14	Y/1	NR		100
26/09E-14Q1(1990)	SR/d	14	N	R	BS	20-
26/09E-21G1(1970)	SR/d	14	N	NR		100
26/09E-22F1(1987)	DT/p	14	Y/4	R	SX	20-
26/09E-22F2(1987)	DT/p	14	Y/3	R	SX	20-
26/09E-36R1(1991)	DT/d	14	Y/3	NR		20-
26/10E-19Q1(1964)	DT/p	14	Y/3	NR		100
26/10E-32P1(1982)	DT/p	14	Y/3	NR		100

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-23P1(1982)	DT/d	15	Y/4	R	LND	20-
26/09E-24M1(1982)	DT/d	15	Y/4	R?	?	20-
26/09E-24N1(1982)	SR/p	15	N	R	SC	20-
26/09E-24R1(1982)	DT/p	15	N	R	SC	20-
26/09E-27A1(1974)	DT/p	15	N	NR		20-
26/09E-27A2(1974)	DT/p	15	N	NR		20-
26/09E-27B1(1974)	DT/d	15	Y/1	R	LND	20-
26/09E-27D1(1976)	DT/p	15	N	R	SC	20+
26/10E-30E1(1982)	DT/p	15	Y/4	NR		20-
26/10E-30P1(1982)	DT/p	15	Y/4	NR		20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/08E-01G1(1982)	SR/p	19	N	NR		20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-01K1(1982)	DT/d	16	Y/4	R	?	20-
26/09E-10J1(1990)	SR/d	16	N	R	?	20+
26/09E-10J2(1987)	SR/p	16	Y/1	NR		20+
26/09E-12F1(1991)	SR/d	16	Y/1	R	?	20+
26/09E-12G1(1964)	DT/q	16	Y/1	NR		20-
26/09E-12H1(1976)	DT/p	16	Y/4	NR		20-
26/09E-12H2(1976)	DT/p	16	Y/1	NR		20-
26/09E-12Q1(1976)	DT/q	16	Y/1	R	SX	100
26/09E-14M1(1987)	SR/d	16	N	R	BS	20-
26/09E-15A1(1982)	DT/p	16	Y/3	R	LND	20-
26/09E-15H1(1989)	DT/p	16	Y/3	R	CS	20-
26/09E-15Q1(1987)	DT/d	16	Y/3	NR		20-
26/09E-16N1(1974)	SR/d	16	N	R	BS	20-
26/09E-16R1(1982)	SR/d	16	N	NR		20-
26/09E-32R1(1982)	SR/p	16	Y/1	R	SC	20+
26/09E-33J1(1972)	DT/d	16	Y/4	R	SC	20-
26/09E-33J2(1986)	DT/d	16	Y/4	R	SC	20-
26/09E-33J3(1986)	SR/d	16	N	R	SC	20-
26/09E-33K1(1976)	DT/p	16	Y/1	R	LND	20-
26/09E-34L1(1982)	SR/p	16	Y/4	R	SC	20-
26/09E-34N1(1982)	DT/d	16	Y/1	R	SC	20-
26/09E-35B1(1991)	DT/p	16	Y/3	NR		20-
26/09E-35H1(1991)	DT/d	16	Y/3	R	SC	20-
26/09E-35R2(1984)	DT/p	16	Y/3	NR		20-
26/09E-36B1(1982)	DT/P	16	Y/4	NR		20-
26/09E-36C1(1982)	DT/P	16	Y/4	R	SC	20-
26/10E-30R1(1982)	DT/p	16	Y/1	NR		100
26/10E-31A1(1974)	DT/p	16	Y/3	R	SC	20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/08E-23M1(1964)	SR/d	18	Y/1	NR		20+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/09E-06A1(1974)	SR/p	17	N	R	SC	20-
25/09E-06B1(1974)	SR/p	17	N	R	SC	20-
25/09E-06F1(1974)	SR/p	17	N	NR		20-
25/09E-06F2(1974)	SR/P	17	N	NR		20-
26/09E-03L1(1976)	SR/d	17	N	R	LND	20-
26/09E-04Q1(1976)	SR/d	17	N	R	BK	20-

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/07E-11F1(1964)	LPD/a	20				
25/07E-11J1(1992)	SR/d	20	N	NR		20-
25/07E-12E1(1964)	LPD/a	20				
25/07E-23B1(1964)	LPD/a	20				
25/08E-04D1(1964)	SR/d	20	N	R	BS	20-
25/08E-05B1(1964)	SR/d	20	N	NR		20-
25/08E-06F1(1964)	LPD/a	20				
26/08E-01A1(1964)	LPD/a	20				
26/08E-02B1(1982)	SR/d	20	Y/4	NR		20-
26/08E-02G1(1982)	SR/d	20	Y/4	NR		20-
26/08E-02K1(1982)	SR/d	20	Y/4	NR		20-
26/08E-04N1(1964)	SR/d	20	N	NR		20-
26/08E-04P1(1964)	DT/p	20	N	NR		20-
26/08E-09C1(1964)	SR/p	20	N	NR		20-
26/08E-09C2(1964)	LPD/a	20				
26/08E-17Q1(1964)	LPD/a	20				
26/08E-22N1(1964)	LPD/a	20				
26/08E-29G1(1964)	LPD/a	20				
26/08E-29L1(1964)	LPD/p	20				
26/08E-29R1(1964)	LPD/a	20				
26/08E-31A1(1982)	SR/d	20	N	NR		20-
26/08E-31F1(1964)	LPD/a	20				
26/08E-31G1(1964)	LPD/a	20				
26/08E-32B1(1982)	SR/d	20	N	R	SC	20-
26/08E-32C1(1964)	LPD/a	20				
26/08E-32D3(1964)	LPD/a	20				
26/08E-32L1(1964)	LPD/a	20				
26/08E-32L2(1964)	SR/d	20	N	NR		20-
26/08E-32L5(1964)	LPD/a	20				
26/08E-32M1(1964)	SR/d	20	N	NR		20-
26/08E-32M2(1964)	SR/d	20	N	NR		20-
26/08E-35C1(1964)	LPD/a	20				
26/08E-35F1(1964)	LPD/a	20				
26/08E-35K1(1964)	LPD/a	20				
26/08E-35L1(1964)	LPD/a	20				
26/09E-06D1(1964)	LPD/a	20				
26/09E-09N2(1964)	LPD/a	20				
26/09E-10E1(1964)	LPD/a	20				
26/09E-15E1(1976)	SR/p	20	Y/3	NR		20-
26/09E-15F1(1964)	LPD/a	20				
26/09E-16B2(1964)	LPD/a	20				
26/09E-16E1(1970)	SR/d	20	N	NR		20-
26/09E-16K3(1964)	LPD/a	20				
26/09E-16M2(1964)	LPD/a	20				
26/09E-17B1(1964)	LPD/a	20				
26/09E-17D1(1964)	LPD/a	20				
26/09E-18H1(1974)	SR/d	20	N	R	SC	20-
26/09E-18J1(1974)	SR/d	20	N	R	SC	20-
26/09E-18K1(1964)	LPD/a	20				
26/09E-18R1(1974)	SR/d	20	N	R	SC	20-

26/09E-19K1(1964) LPD/a 20

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-30B1(1964)	LPD/a	20				
26/09E-31H1(1964)	LPD/a	20				
26/09E-31L1(1964)	LPD/a	20				
26/09E-31N1(1964)	LPD/a	20				
26/09E-31N2(1964)	LPD/a	20				

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
25/07E-01A1(1982)	SR/d	22	N	NR		20-
25/07E-01F1(1982)	SR/d	22	N	NR		20-
25/07E-01G1(1982)	SR/d	22	N	NR		20-
25/07E-01H1(1982)	SR/d	22	N	NR		20-
25/07E-01Q1(1982)	SR/d	22	N	NR		20-
25/07E-02R1(1992)	SR/d	22	N	NR		20-
25/07E-14R1(1992)	DT/p	22	Y/1	NR		50+

Number	LS Type	MWMU	Del.	Assoc.	Type	Age
26/09E-05B1(1988)	DT/p	23	Y/4	NR		20-
26/09E-05B2(1988)	SR/SA/p	23	Y/4	NR		20-
26/09E-05C1(1988)	SR/d	23	N	R	BS	20-
26/09E-07E1(1970)	DT/d	23	Y/4	R	PIT	20-

MASS WASTING MAP UNIT NUMBER 1

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				3	3
Clear Cut 20 - 50 years					
Partial Cut					
Road	4			3	7
Stream Crossing				2	2
Landing				1	1
Other Forest Practices					
Wildfire					
Mature Forest				3	3
Non-Forest Land Use					
Totals					

Total Landslide Density (Failures / Acre) = .0595

Non Road Related Landslide Density (Failures / Acre) = .0223

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 2

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	7				7
Clear Cut 20 - 50 years	1		6		7
Partial Cut					
Road	2			1	3
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest	1		1		2
Non-Forest Land Use					
Totals	11		7	1	19

Total Landslide Density (Failures / Acre) = .0500

Non Road Related Landslide Density (Failures / Acre) = .0289

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 3

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				1	1
Clear Cut 20 - 50 years				1	1
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals				2	2

Total Landslide Density (Failures / Acre) = .0220

Non Road Related Landslide Density (Failures / Acre) = .0220

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 4

ACTIVITY	MASS-WASTING FEATURE: Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				1	1
Clear Cut 20 - 50 years				2	2
Partial Cut					
Road				3	3
Stream Crossing					
Landing	1			1	2
Other Forest Practices					
Wildfire					
Mature Forest				1	1
Non-Forest Land Use					
Totals	1			8	9

Total Landslide Density (Failures / Acre) = .0150

Non Road Related Landslide Density (Failures / Acre) = .0065

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 5

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				2	2
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals				2	2

Total Landslide Density (Failures / Acre) = .0156

Non Road Related Landslide Density (Failures / Acre) = .0156

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 6

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years					
Clear Cut 20 - 50 years	1				1
Partial Cut					
Road	3				3
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	4				4

Total Landslide Density (Failures / Acre) = .0909

Non Road Related Landslide Density (Failures / Acre) = .0227

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 7

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	5			4	9
Clear Cut 20 - 50 years	1				1
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest	1			1	2
Non-Forest Land Use					
Totals	7			5	12

Total Landslide Density (Failures / Acre) = .1000

Non Road Related Landslide Density (Failures / Acre) = .1000

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 8

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	2			2	4
Clear Cut 20 - 50 years				2	2
Partial Cut					
Road				2	2
Stream Crossing					
Landing	1				1
Other Forest Practices					
Wildfire					
Mature Forest	1			2	3
Non-Forest Land Use					
Totals	4			8	12

Total Landslide Density (Failures / Acre) = .0448

Non Road Related Landslide Density (Failures / Acre) = .0336

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 9

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				3	3
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing				1	1
Other Forest Practices					
Wildfire					
Mature Forest	1				1
Non-Forest Land Use					
Totals	1			4	5

Total Landslide Density (Failures / Acre) = .0267

Non Road Related Landslide Density (Failures / Acre) = .0214

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 10

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	2				2
Clear Cut 20 - 50 years					
Partial Cut					
Road	1				1
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest	3				3
Non-Forest Land Use					
Totals	6				6

Total Landslide Density (Failures / Acre) = .0245

Non Road Related Landslide Density (Failures / Acre) = .0204

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 11

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				1	1
Clear Cut 20 - 50 years					
Partial Cut					
Road	1				1
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	1			1	2

Total Landslide Density (Failures / Acre) = .0274

Non Road Related Landslide Density (Failures / Acre) = .0137

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 12

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years					
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals					0

Total Landslide Density (Failures / Acre) = 0

Non Road Related Landslide Density (Failures / Acre) = 0

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 13

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years					
Clear Cut 20 - 50 years				2	2
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals				2	2

Total Landslide Density (Failures / Acre) = .0001

Non Road Related Landslide Density (Failures / Acre) = .0001

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 14

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				1	1
Clear Cut 20 - 50 years					
Partial Cut					
Road	1			1	2
Stream Crossing				2	2
Landing				1	1
Other Forest Practices					
Wildfire					
Mature Forest	1			4	5
Non-Forest Land Use					
Totals	2			9	11

Total Landslide Density (Failures / Acre) = .0022

Non Road Related Landslide Density (Failures / Acre) = .0012

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 15

ACTIVITY	MASS-WASTING FEATURE: Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years				4	4
Clear Cut 20 - 50 years					
Partial Cut					
Road	1			3	4
Stream Crossing					
Landing				2	2
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	1			9	10

Total Landslide Density (Failures / Acre) = .0038

Non Road Related Landslide Density (Failures / Acre) = .0015

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 16

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	1			7	8
Clear Cut 20 - 50 years	1				1
Partial Cut					
Road	7			8	15
Stream Crossing				1	1
Landing				2	2
Other Forest Practices					
Wildfire					
Mature Forest				1	1
Non-Forest Land Use					
Totals	9			19	28

Total Landslide Density (Failures / Acre) = .0023

Non Road Related Landslide Density (Failures / Acre) = .0008

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 17

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	2				2
Clear Cut 20 - 50 years					
Partial Cut					
Road	3				3
Stream Crossing					
Landing	1				1
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	6				6

Total Landslide Density (Failures / Acre) = .0074

Non Road Related Landslide Density (Failures / Acre) = .0025

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 18

ACTIVITY	MASS-WASTING FEATURE: Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years					
Clear Cut 20 - 50 years	1				1
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	1				1

Total Landslide Density (Failures / Acre) = .0435

Non Road Related Landslide Density (Failures / Acre) = .0435

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 19

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	1				1
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	1				1

Total Landslide Density (Failures / Acre) = .0001

Non Road Related Landslide Density (Failures / Acre) = .0001

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 20

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	13			1	14
Clear Cut 20 - 50 years					
Partial Cut					
Road	5				5
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	18			1	19

Total Landslide Density (Failures / Acre) = .0052

Non Road Related Landslide Density (Failures / Acre) = .0038

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 21

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years					
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals					0

Total Landslide Density (Failures / Acre) = 0

Non Road Related Landslide Density (Failures / Acre) = 0

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 22

MASS-WASTING FEATURE

ACTIVITY	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	6				6
Clear Cut 20 - 50 years					
Partial Cut					
Road					
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest				1	1
Non-Forest Land Use					
Totals	6			1	7

Total Landslide Density (Failures / Acre) = .0055

Non Road Related Landslide Density (Failures / Acre) = .0055

Form aa-2. Mass-wasting summary table.

MASS WASTING MAP UNIT NUMBER 23

ACTIVITY	MASS-WASTING FEATURE				
	Shallow-Rapid LS	Large-Persistent Deep-Seated Failures	Small-Sporadic Deep-Seated Failures	Debris Torrent	Totals
Clear Cut 0-20 years	1			1	2
Clear Cut 20 - 50 years					
Partial Cut					
Road	1			1	2
Stream Crossing					
Landing					
Other Forest Practices					
Wildfire					
Mature Forest					
Non-Forest Land Use					
Totals	2			2	4

Total Landslide Density (Failures / Acre) = .0012

Non Road Related Landslide Density (Failures / Acre) = .0012

Form aa-2. Mass-wasting summary table.

TOLT RIVER WAU
LANDSLIDE DENSITY BY MWMU

MWMU #	ACRES	TOTAL LANDSLIDE DENSITY (failures / acre)	NON ROAD DENSITY (failures / acre)
1	269	.0595	.0223
2	380	.0500	.0289
3	92	.0220	.0220
4	613	.0150	.0065
5	128	.0156	.0156
6	44	.0909	.0227
7	120	.1000	.1000
8	268	.0448	.0336
9	187	.0267	.0214
10	245	.0245	.0204
11	73	.0274	.0137
12	3,108	0	0
13	23,674	.0001	.0001
14	5,025	.0022	.0012

MWMU #	ACRES	TOTAL LANDSLIDE DENSITY	NON ROAD DENSITY
15	2,607	.0038	.0015
16	12,383	.0023	.0008
17	810	.0074	.0025
18	23	.0435	.0435
19	9,379	.0001	.0001
20	3,682	.0052	.0038
21	278	0	0
22	1,262	.0055	.0055
23	3,251	.0012	.0012

Map-Unit Management Sensitivity Worksheet

Mass-Wasting Map Unit #	Natural Instability/ Susceptibility	Sensitivity to Forest Roads	Sensitivity to Harvest Activities	Sensitivity to Other Forest Practices Specify
1	Mod	High	Mod	
2	High	High	High	
3	?	High	High	
4	?	High	Mod	
5	?	High	Mod	
6	?	High	Mod	
7	High	High	High	
8	High	High	High	
9	Mod	High	High	
10	High	High	High	
11	?	Mod	High	
12	?	Low	Low	
13	?	LOW	LOW	
14	Mod	Mod	Mod	

Form aa-3. Map-unit management sensitivity worksheet.

Map-Unit Management Sensitivity Worksheet

Mass-Wasting Map Unit #	Natural Instability/ Susceptibility	Sensitivity to Forest Roads	Sensitivity to Harvest Activities	Sensitivity to Other Forest Practices Specify
15	?	Mod	Mod	
16	?	Mod	Mod	
17	?	Mod	Mod	
18	Mod	Mod	Mod	
19	?	Mod	Mod	
20	Mod	Mod	Mod	
21	?	High	Mod	
22	?	Mod	Mod	
23	?	Mod	Mod	

Form aa-3. Map-unit management sensitivity worksheet.

20-10 Very large timbered deep seated landslide in Qpf. Some stability problems on up slope areas in 1942 photos, most have no delivery, but area on eastern boundary may have delivery and should be checked prior to harvest. River erosion is steepening the toe along two areas of the landslide, these areas in MWMU 2.

20-11 Rather indistinct harvested deep seated landslide in Qpf. River erosion is steepening toe in one area. Area from break in slope down to river is in MWMU 2.

20-12 Large rather indistinct timbered deep seated landslide in glacial material over the top of bedrock. No evidence of instability seen on air photos or seen from across the river. No areas of instability mapped but area should be reviewed prior to harvest.

20-13 Large timbered deep seat landslide in bedrock. No unstable areas mapped. Erosion by North Fork creek may be minimal due to the low gradient of the stream.

20-14 Smaller timbered deep seated landslide in glacial material over the top of bedrock. Steep failure surface, shallow rapid failures occurring throughout. Entire failure in MWMU 2 but delivery is questionable

20-15 Small harvested fairly indistinct deep seated landslide in Qpf. Small scarp failure has occurred but no delivery. No unstable areas found.

20-16 Large harvested deep seated landslide in Qpf (?). Toe is on outside of bend of the river and is being steepened. This area from the break in slope down to the river is in MWMU 2.

20-17 Large timbered deep seated landslide in Qpf. Appears toe in being steepened at upstream margin of the failure. This area in MWMU 2. No other areas appear to be over steepened but lower portions of the failure should be investigated prior to harvest.

20-18 Large timbered deep seated landslide in Qpf (?). Rather oddly shaped, appears to be some SSD on toe of deposit. This area mapped as MWMU 2, also recharge area of this SSD should be investigated.

20-19 Small timbered deep seated landslide in Qpf (?). Steep landslide surface, shallow rapid failures throughout. Entire failure in MWMU 2.

20-20 Large harvested deep seated landslide in Qpf. Numerous failures have occurred on the failure surface during the last 30 years. Entire failure in MWMU 2.

20-21 Large harvested deep seated landslide in Qpf. Steep landslide surface, shallow rapid failures throughout. Entire failure in MWMU 2.

20-22 Large timbered deep seated landslide in glacial deposits over bedrock. Recent shallow rapid failures on southern portion of the failure. This very steep area in MWMU 2, but should be field verified.

20-23 Small timbered deep seated landslide in glacial deposits over bedrock. Steep landslide surface, shallow rapid failures throughout. Entire failure in MWMU 2.

20-24 Large timbered deep seated landslide in bedrock. Seems to be primarily sensitive to road construction, low potential for delivery. No unstable areas mapped.

20-25 Large timbered deep seated landslide in bedrock. River is eroding along toe of failure and shallow rapid stream adjacent failures are occurring. From the river up to the major break in slope (a fair distance on this failure) in in MWMU 2.

20-26 Large timbered ancient deep seated landslide in bedrock. Basically an old rockfall, should be fairly insensitive to forest practices. Some potential for smaller rockfalls but no delivery. No unstable areas mapped.

20-27 Large harvested indistinct deep seated landslide in glacial material and bedrock. This a large area of thin landslide deposits over bedrock. This area has an indistinct scarp but a large area of hummocky topography. Unstable areas were mapped on the toe where the small streams formed sharp little canyons in the deposits. The major stream has eroded very steep slopes along the base of the failure but the only failures that occurred along this slope during the past harvest were below landings, perhaps ground disturbance plays of major role in the slope stability of this slope.

20-28 Large timbered indistinct deep seated landslide in glacial materials and bedrock. Even the existence of this failure is in doubt, identified on geologic map of the area but hard to distinguish on air photos. Large bench below failure, no delivery. No unstable areas mapped.

20-29 Large harvested deep seated landslide in bedrock. Stream in eroding at toe of failure. Area from the stream up to the break in slope mapped in MWMU 2.

20-30 Large harvested indistinct deep seated landslide in bedrock. No river erosion on toe, but instability occurs where small stream on margin of failure is trying to erode down through the landslide deposits. This area in MWMU 2

20-31 Large harvested deep seated landslide in bedrock. Unusual failure with recent wide shallow rapid failures on the scarp slope. Also stream is causing some steepening of the toe of the failure and a small stream is eroding down through the landslide deposits. These areas in MWMU 2.

20-32 Large harvested unusually shaped deep seated landslide in bedrock. Fairly large bench but not much of a scarp. Area adjacent to the stream could be over steepened and is mapped in MWMU 2.

20-33 Large harvested indistinct deep seated landslide in bedrock and glacial material. For the most part toe of failure is away from the river but at upstream margin of the failure the river is eroding at the toe. Slump in this area reactivated after harvest up slope. Harvest in the recharge area of this smaller slump (MWMU 11) may play role in reactivation.

20-34 Large timbered deep seated landslide in Qpf. Recent slumps have occurred on the toe of this failure. Observations of others indicate recent deep seated movement (since the last harvest) may have occurred through out this failure. If so recharge area of the failure must be investigated prior to harvest. Because of smaller deep seated failures on the toe, the entire failure is in MWMU 2.

20-35 Smaller timbered deep seated landslide in glacial deposits. Small slump has occurred on the toe of the failure where stream is eroding. Also small shallow rapid slides on scarp, failure should be investigated prior to harvest to see if these are related. Area where toe is being eroded by the river mapped in MWMU 2.

20-36 Smaller harvested deep seated landslide in Qpf. Small shallow rapid failures in timber below bench. Area from river up to bench in MWMU 2.

20-37 Smaller partially harvested deep seated landslide in bedrock. Appears to be an ancient rockfall which has deposited a considerable amount of material in the valley bottom, probably damming the stream at one time. The stream is now eroding down through these deposits, leaving very steep slopes on both sides of the stream for a considerable distance downstream. This area in MWMU 2.